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(54) METHOD FOR MOUNTING ELECTRONIC CIRCUIT CHIP

(57) In a method of mounting a planar electronic circuit chip onto a flexible sheet together with another planar electronic element, the electronic circuit part and the another electric element are selected so that the planar surface of the another electric element is greater than the planar surface of the electronic circuit chip, and the another electric element and the electronic circuit chip are mounted on the sheet so that the planar surface of the another electric element and the planar surface of the electronic circuit chip are in parallel with the sheet surface, and the planer surface of the electronic circuit chip is accommodated within the planar surface of the another electric element as viewed in a direction perpendicular to the sheet surface.

FIG. 2a

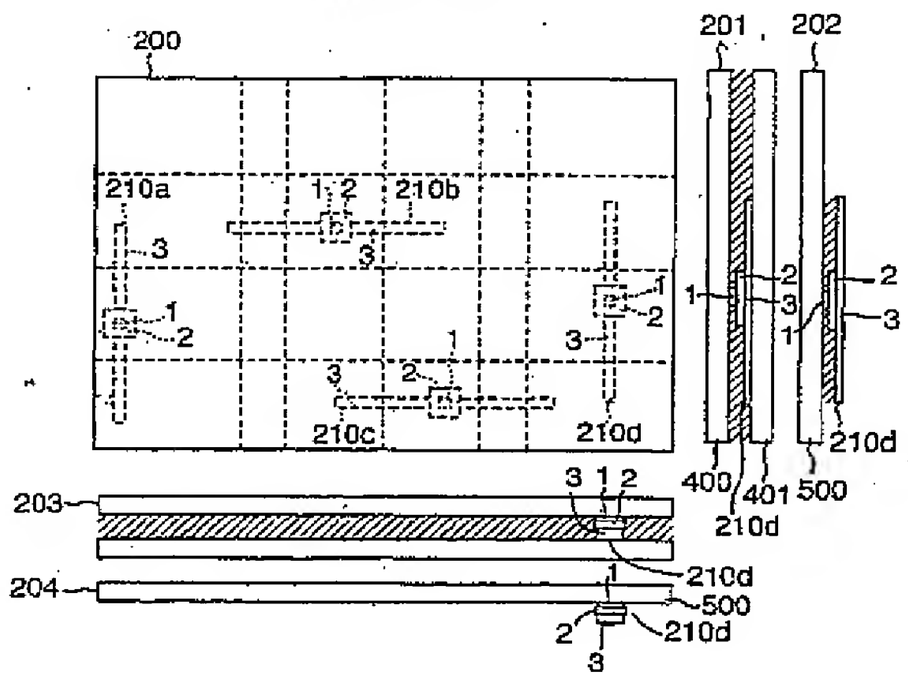
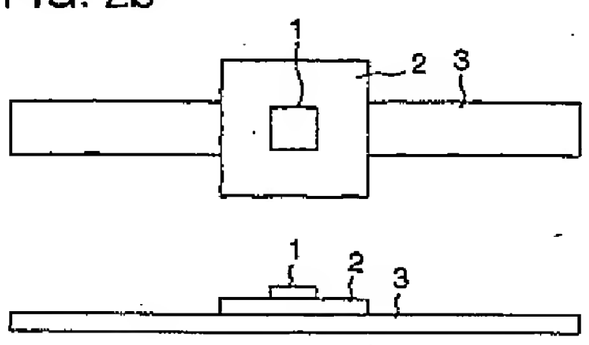


FIG. 2b



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Best Mode For Carrying Out The Invention

[0011] Explanation will be made hereinbelow of embodiments of the present invention.

[0012] In the following explanation of the embodiments according to the present invention, there is exemplified in such a configuration that an electronic circuit chip for storing data is mounted on a paper together with an element for reading the data from the electronic circuit chip in a noncontact manner. However, it is noted that an electronic circuit chip to be mounted may be any of those other than that mentioned above, and further, any of soft materials other paper on which the electronic circuit chip is mounted may be used if it may be largely bent or it may be folded.

[0013] Further, a thin and laterally very long sheet such a tape may be used other than a planer material. That is, it may be the one which can be rolled up.

[0014] Explanation will be made of a first embodiment of the present invention.

[0015] Referring to Fig. 1 which shows a circuit composed of an electronic circuit chip adapted to be mounted on a paper in this embodiment, and an element for reading data from the electronic circuit chip in a noncontact manner, there is shown an electronic circuit chip 1 in which electronic circuits are integrated on a silicon chip. Further, elements, that is, a capacitor 2 and an antenna 3 are elements for reading data from the electronic circuit chip 1 in a noncontact manner.

[0016] When an electromagnetic wave is applied to the above-mentioned circuit from the outside, the electromagnetic wave induces a current running through the capacitor through the antenna 3, and a power is charged in the capacitor 2. Further, the power charged in the capacitor causes the electronic circuit 1 to be energized so that data previously stored is transmitted in the form of an electromagnetic wave from the antenna 3. Accordingly, through the application of an electromagnetic wave, the data stored in the electronic circuit chip can be read on the outside thereof in a non-contact manner.

[0017] Fig. 2a shows a condition in which the circuit is mounted on paper, reference numeral 200 denotes the outer surface of a sheet on which the circuit is mounted. In the figure, reference numerals 210a to 210d denote configuration examples of the circuits which are mounted on a paper sheet.

[0018] It is noted here that the circuit 210d is bonded so as to be held between two sheets 400, 401 (201, 203) or a circuit 210d is bonded to a rear surface of a paper sheet 500.

[0019] Further, the circuit is mounted on the paper sheet in such a configuration that the electronic circuit chip is prevented from being mounted at a position on a crease which is created in the paper sheet, as indicated by a one-dot chain line, and a two-dot chain line in the top view 200, when the paper sheet is folded. This figure shows such an example that the paper sheet is possibly folded into 1/2, 1/3 or 1/4 in the lateral direction thereof, and is possibly folded into 1/2 or 1/4 in the longitudinal direction. The one-dot chain lines and the two-dot chain lines in the figure exhibit creases when the paper sheet is folded as mentioned above.

[0020] A position where a crease is possibly created so that the electronic circuit chip 1 is not located, is a position in accordance with a configuration of folding if the configuration of folding has been previously known. Further, if no configuration with which the paper is folded are previously known, a position which is one or a plurality of configurations which are usually used in various paper folding methods in accordance with kinds or uses of the paper sheet. That is, in general, the position may be on a crease which is created at any of positions obtained by 1/n of the length of the paper sheet, where n is an integer, that is, in general 2, 3, 4, 5, 6, 8, 16 in both vertical and horizontal directions, that is, positions which are 1/2, 1/3, 1/4, 1/6, 1/8, 1/16 of the length of the paper sheet in each of the longitudinal and lateral directions, where a crease is possibly created, except a special kind or use of the paper sheet.

[0021] By locating the electronic circuit chip on the paper sheet, other than a position where a crease is created and where a large moment force is exerted when the paper sheet is folded, it is possible to prevent the electronic circuit chip 1 from being damaged when the paper sheet is folded.

[0022] It is noted that the circuit 210a is arranged so that the electronic circuit chip 1 is located at a position in the vicinity of an edge of the paper sheet. Usually, since no large force is exerted to a position in the vicinity of an edge of the paper sheet, a degree of the force exerted to the electronic circuit chip 1 and the frequency of the exertion of the force to the electronic circuit chip 1 can be expected to be less. Alternatively, in such a case that concavities and convexities are impressed to the paper sheet for blind persons so that hard parts are formed, the electronic circuit chip 1 may be located in any of these parts since it may be expected to decrease the force exerted to the electronic circuit chip 1 located in this part.

[0023] Further, in such a case that an antenna 3 which has a stralt-line like shape as a whole, as in this embodiment, the circuit is arranged so that the antenna 3 is located in parallel with a side of the paper sheet as in the configuration examples 210a to 210d. Usually, the paper sheet is bent or folded in parallel with a side of the paper sheet, and accordingly, a degree of a force exerted to the antenna 3 and the frequency of exertion of forces exerted to the antenna 3 can be expected to be less.

[0024] Further, the upper bottom surface (which is a surface in parallel with the surface) of the sheet of the electronic circuit chip 1 which is weak against a force in the bending direction, is designed so as to have a small size in order to

[0034] When a force and a moment are exerted to the paper sheet so that the long sides of the planar surface of the electronic circuit chip are curved, the force and the moment are effected in various positions on the electronic circuits chip. Estimating that one of the short sides of the planar surface of the electronic circuit chip is set as a fixed end while the other side on the opposite side is set as a free end, the force and the moment can be exhibited being substituted by the equally distributed loads exerted over the entire area of the planar surface, a concentrated load exerted to the free end, and a moment exerted to the free end. Even in such a case that the electronic circuit chip is held between the paper sheets, and also in such a case that it is bonded to the upper surface of the paper sheet, it is approximated to a similar configuration.

[0035] Referring to Fig. 5 which is a view approximately exhibits a force and a moment which are exerted so as to curve the electronic circuit chip, a part indicated by rightward upward oblique lines exhibits a section of the electronic circuit chip 41, in parallel with the long sides of the planer surface thereof. The short sides of the planar surface of the electronic circuit chip 41 correspond to opposite ends of the section of the electronic circuit chip 41 in Fig. 4. Of these ends, the left end serves as the free ends while the right end serves as the fixed end. Referring to Fig. 4, the fixed part is exhibited by rightward downward oblique lines. Referring to this figure, there are shown a thickness H (m) of the electronic circuit chip 41, the length L (m) of the long sides of the electronic circuit chip, equally distributed loads P (N/m^2) per unit area, which are exerted over the entire area of the planar surface of the electronic circuit chip 41, a concentrated load W (N/m) per unit length, exerted to the free end, and a bending moment M (N) per unit length, exerted to the free end.

[0036] The forces P and W and the moment M with which the electronic circuit chip 41 is curved, are estimated to be exerted within the section thereof, and a positive force or moment is taken in a direction in which the electronic circuit chip 41 is curved downward. In this embodiment the forces P and W and the moment M have positive values.

[0037] The x-axis is taken rightward from the free end as the origin. A moment per unit length, exerted to a position x (m) by the equally distributed loads P, is exhibited by $Px^2/2$(N). A moment per unit length, exerted to a position x (m) by the concentrated load W is exhibited by Wx (N). A moment per unit length exerted by the bending moment M is exhibited by a constant value M(N), independent from the value x. Accordingly, the total value M_{SUM} of the moments per unit length, exerted to the position x (m) is exhibited by $Px^2/2 + Wx + M$(N). x is taken in a range from o to L, and accordingly, M_{SUM} becomes maximum at x = L, thus,

$$M_{MAX} = PL^2/2 + WL + M(N)$$

is obtained.

[0038] In this embodiment, since the shape of the electronic circuit chip can be approximated to a rectangular parallelepiped body, the bending stress exerted to the electronic circuit chip 41 becomes maximum at a position where the maximum bending moment is exerted, having a value σ_{MAX} becomes $6M_{MAX}/H^2(N/m^2)$.

[0039] If the bending strength of the electronic circuit chip 41 is denoted by $\sigma(N/m_2)$, since a condition with which the electronic circuit 41 can be prevented from being broken, is $\sigma \geqq \sigma_{MAX}$,

$$3PL^2 + 6WL + 6M - \sigma H^2 \leqq 0 \qquad \text{- (Formula 1)}$$

is obtained.

[0040] By solving the equation for L, H, σ,

$$L \leqq \{-W + (W^2 - PA)^{1/2}\}/P \qquad \text{- (Formula 2)}$$

$$H \geqq \{3(PL^2 + 2WL + 2M)/\sigma\}^{1/2} \qquad \text{- (Formula 3)}$$

$$\sigma \geqq (3PL^2 + 6WL + 6M)/H^2 \qquad \text{- (Formula 4)}$$

are obtained. In the formula 2, A is $A = 2M - \sigma H^2/3$.

[0041] As a condition with which the electronic circuit chip is prevented from being broken, the maximum value of the length L (m) of the long sides is obtained from the formula 2, the minimum value of the thickness H (m) is obtained from the formula 3, and the minimum value of the bending strength $\sigma(N/m^2)$ is obtained from the formula 4.

2. A method of mounting an electronic circuit chip onto a foldable sheet, **characterized in that** the electronic circuit chip is mounted to the sheet so that the electronic circuits chip is prevented from being located at a position where a crease is formed when the sheet is folded.

3. A method of mounting a circuit chip on a foldable sheet having a rectangular sheet surface, **characterized in that** the electronic circuit chip is mounted on the sheet so as to prevent the electronic circuit chip from being located at least at a position which is obtained by 1/2, 1/3 or 1/4 of the length of longer sides of the sheet surface and which is obtained by 1/2 of short sides of the sheet surface.

4. A method of mounting an electronic circuit chip as set forth in claim 2, **characterized in that** the electronic circuit chip is mounted at a position in the vicinity of an edge of the sheet surface.

5. A method of mounting a planer electronic circuit chip on a foldable sheet having a rectangular sheet surface together with another planar electric element, **characterized in that** setting the planar surface of the another electric element to be slightly smaller than a size of each of rectangular area which are obtained by sectioning the sheet surface by n x m (where n and m are integers larger than 2), and

mounting the another electric element and the electronic circuit chip on the sheet so that the planer surface of the another electric element and the planar surface of the electronic circuit chip are arranged in parallel with the surface of the sheet, and the planar surface of the another electric element is accommodated within one of the rectangular areas which are obtained by sectioning the sheet surface with m x n, as viewed in a direction perpendicular to the sheet surface, and the planer surface of the electronic circuit chip is accommodated within the planar surface of the another electric element as viewed in a direction perpendicular to the sheet surface.

6. A method of mounting an electronic circuit chip as set forth in claim 2, **characterized in that** a long-rod like or a long planar like electric part is mounted on the sheet so that the longitudinal direction of the electric part is coincident with the sidewise direction of the sheet.

7. A method of mounting an electronic circuit chip as set forth in claim 2, **characterized in that** the sheet is made of paper.

8. A method of mounting an electronic circuit chip as set forth in claim 2, **characterized in that** the sheet is tape-like.

9. A method of mounting an electronic circuit chip as set forth in claim 7, **characterized in that** the sheet has a two layer structure, and the electronic circuit chip is mounted between two layers of the sheet.

10. A method of mounting an electronic circuit chip as set forth in claim 7, **characterized in that** the electronic circuit chip is mounted on the surface of one of two front and rear sheet surfaces of the sheet.

11. A planar electric circuit chip mounted on a flexible sheet, **characterized in that** the electronic circuit chip has a thickness, a length of the long sides thereof, and a bending strength which satisfy:

$$3PL^2 + 6WL + 6M - \sigma H^2 \leqq 0$$

where a force exerted to the electronic circuit chip is exhibited by equally distributed loads P (N/m^2) per unit area, exerted to the entire planar surface of the electronic circuit chip, and a concentrated load W (N/m) per unit length, is exerted to the free end, in such a case that one of the short sides of the planar surface of the electronic circuit chip is used as a fixed end while the other short side on the opposite side thereof is used as a free end,

where a moment exerted to the electronic circuit chip is exhibited by a moment M (N) per unit length, exerted to the free end in such a case that one of the short sides of the planar surface of the electronic circuit chip is used as a fixed end while the other short side on the opposite side thereof is used as a free end, and
where H (m) is the thickness of the electronic circuit chip;
L (m) is a length of the long sides of the electronic circuit chip; and
$\sigma(N/m^2)$ is a bending strength of stronger one of a bending strength of the planar another electric element larger than the electronic circuit chip mounted on the planar surface of the another electric element and the bending strength of the electronic circuit chip.

FIG. 1

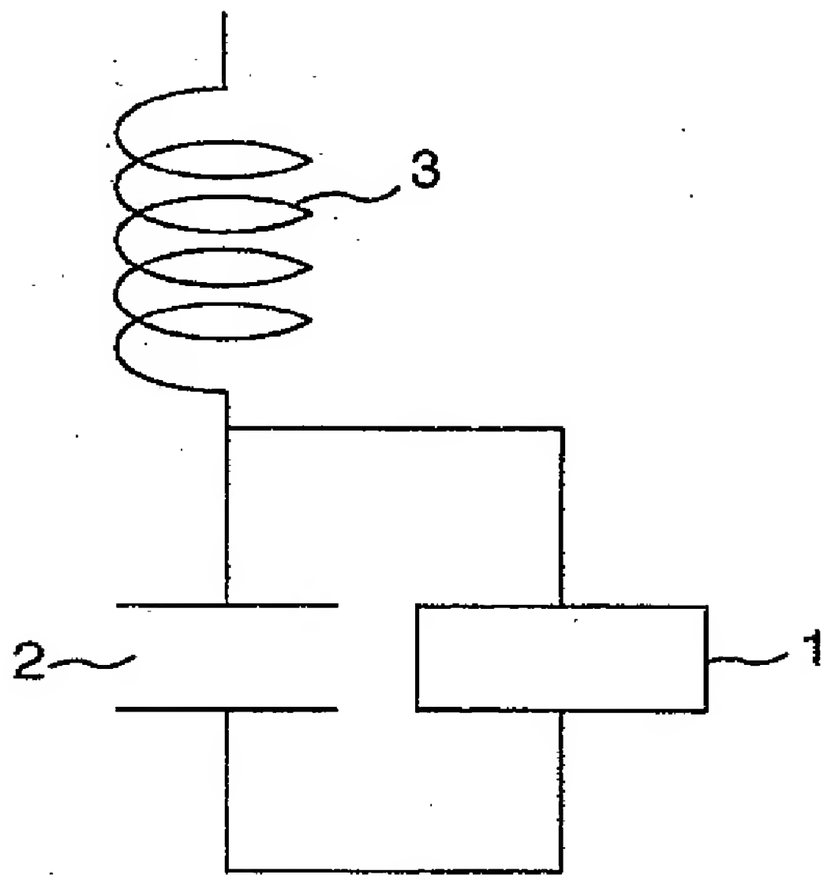


FIG. 3a

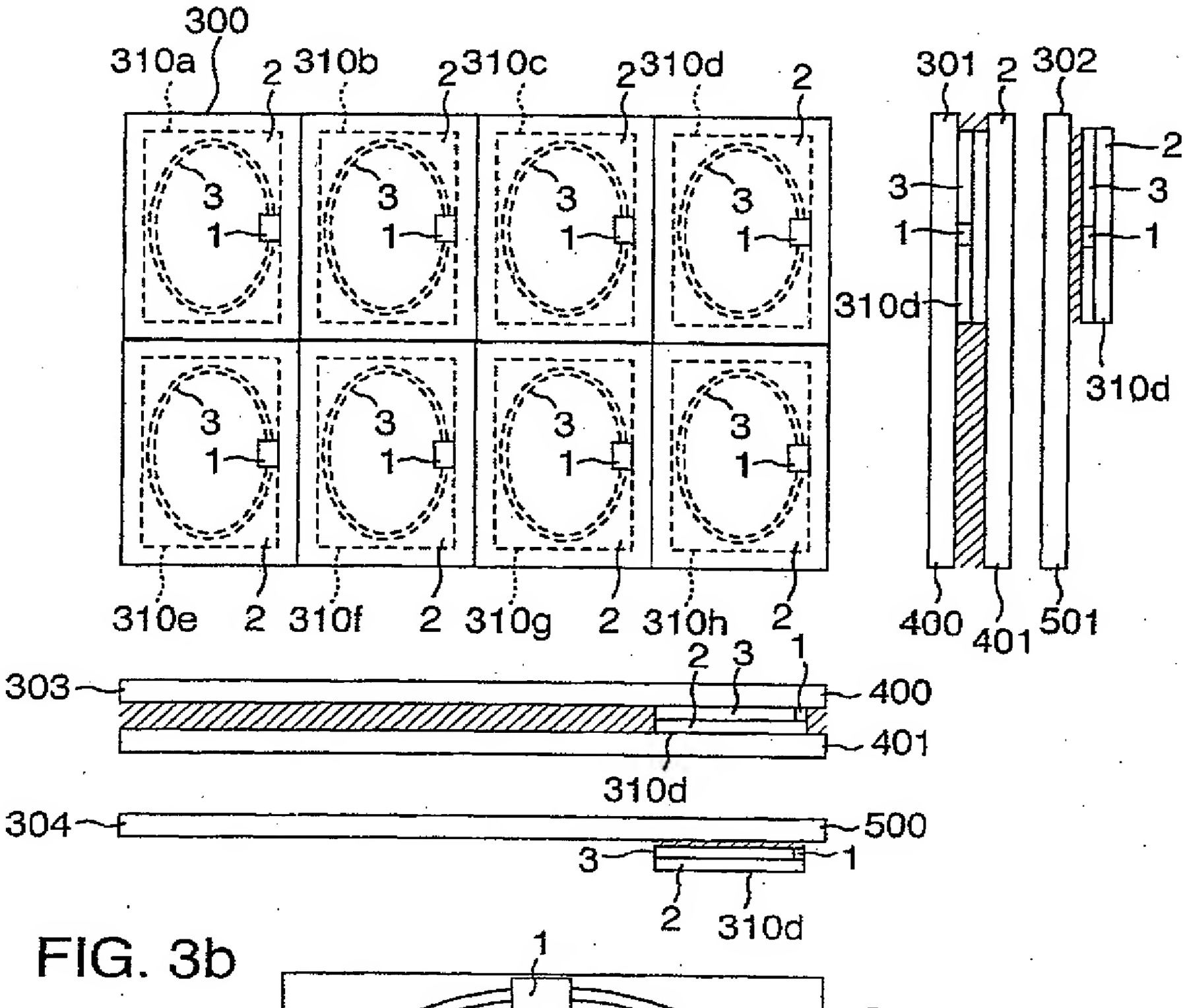


FIG. 3b

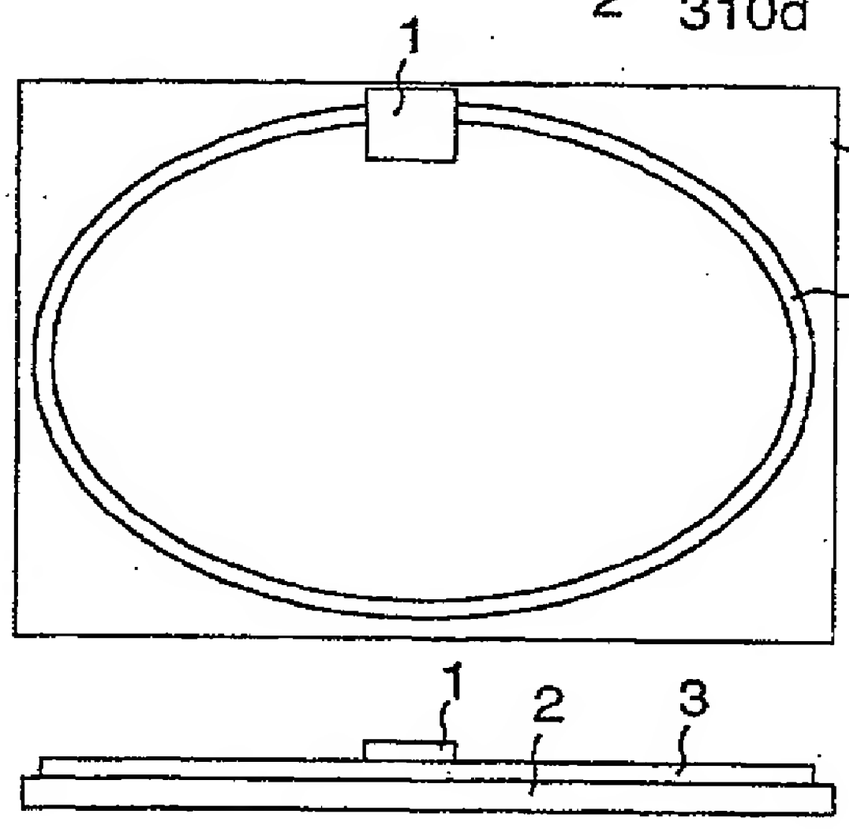
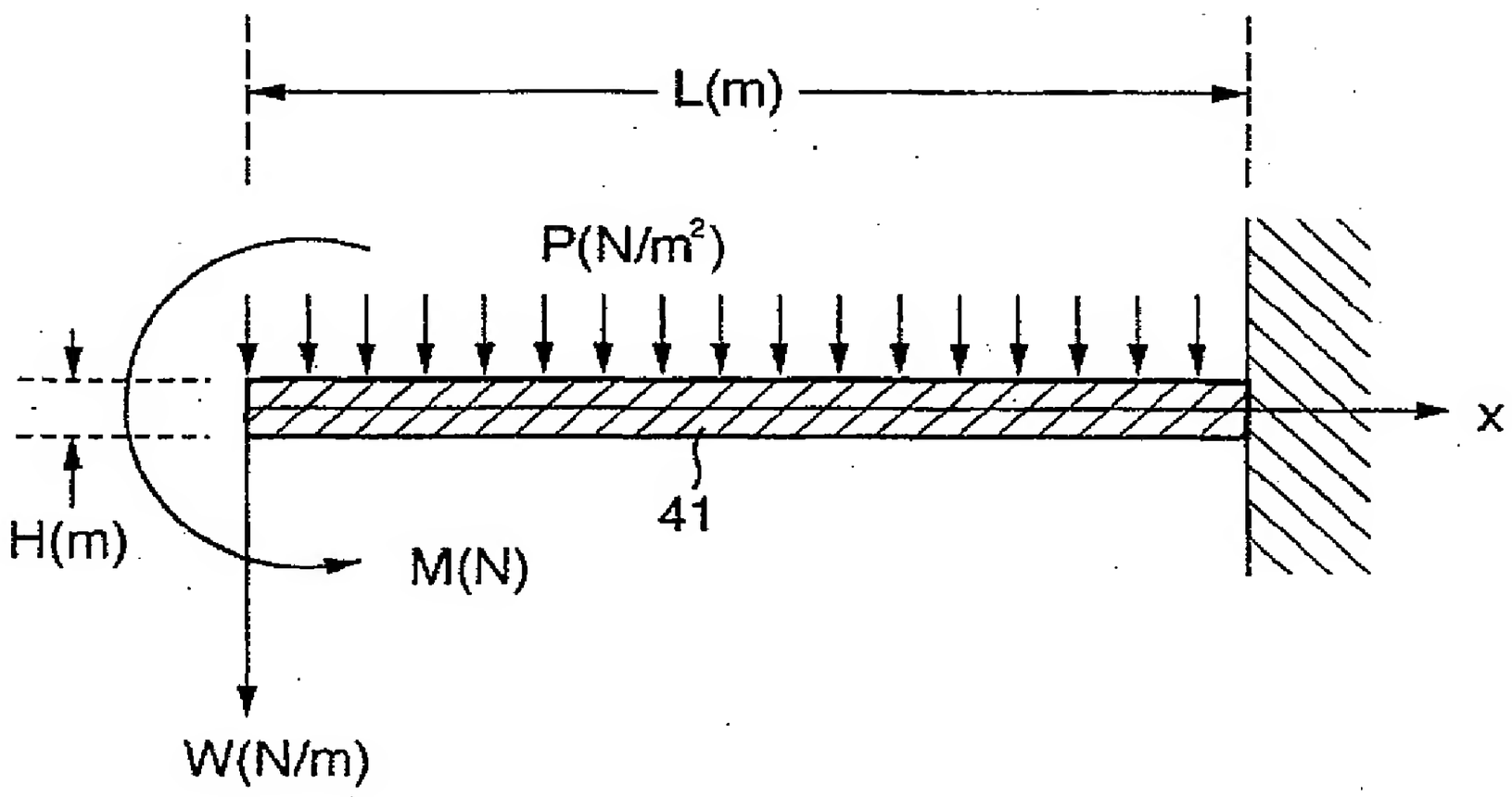


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/06595

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] G06K19/077, B42D15/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] G06K19/077, B42D15/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Jitsuyo Shinan Toroku Koho 1996-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Toroku Jitsuyo Shinan Koho 1994-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
EX	JP, 10-315668, A (KONICA CORPORATION), 02 December, 1998 (02.12.98), Fig. 1; Par. No. [0004] (Family: none)	1
EX	JP, 11-301148, A (Dainippon Printing Co., Ltd.), 02 November, 1999 (02.11.99) (Family: none)	2-10
A	JP, 8-216571, A (Hitachi Chemical Co., Ltd.), 27 August, 1996 (27.08.96) (Family: none)	1-10,13,14

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 February, 2000 (21.02.00)	07 March, 2000 (07.03.00)
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Facsimile No.	Telephone No.

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